# ‘Aha Huliko’a Workshop Series

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## LONG-TERM GOAL

The goal of the workshop series is to review the state-of-the-art, to identify areas of ignorance, and to make recommendations for future research on a topic or topics relevant to the Office of Naval Research.

## OBJECTIVES

The participants of the 2001 workshop were tasked to assess the state of our understanding of the processes that convert variance from the eddy to the molecular scale and that may need to be parameterized in ocean models. This scale range is a highly complex and not yet fully understood dynamical regime and includes eddies, fronts, internal waves, vortical modes, stratified turbulence, double diffusion and mixing.

## APPROACH

## WORK COMPLETED

A four-day workshop on “From stirring to mixing in a stratified ocean” was held from January 16 - 19, 2001, in Honolulu, Hawaii. The workshop brought together observationalists, theoreticians and numerical modelers. The workshop focused on:

(1) The parameterization of mesoscale eddies.

(2) General approaches to stirring, including the application of ideas from dynamical systems theory.

(3) Inertial instability, submesoscale motions, and vortical motions.

(4) The interplay of isopycnal and diapycnal processes.

(5) Processes in the surface mixed layer.

(6) The stirring and mixing of biologically active tracers.

(7) Mixing efficiency, i.e. the fraction of energy lost from the mean flow that produces a vertical buoyancy flux.

(8) Differential mixing of heat and salt.

The lectures of the participants are published in Müller and Henderson (2001). A summary of the workshop is give in Muller and Garrett (2001).

**RESULTS**

Stirring and mixing are the physical processes that convert variance from the eddy to the molecular scale. These processes need to be understood and parameterized in a form that can be implemented into ocean models. The participants identified as major open issues:

(1) What are the constraints on eddy parameterization and how should they be implemented?

(2) What nonlocal effects matter and how can they be parameterized?

(3) How uniform are stirring and mixing processes? Are there any "hotspots", particularly in association with topographic features?

(4) What are the effects of diapycnal boundary processes on eddy parameterization?

(5) What is the parameter dependence of the mixing efficiency or flux Richardson number?

(6) How does energy leak from the slow manifold?

(7) What aspects of stirring and mixing affect biological processes? What do patterns of biological tracers tell us about fluid dynamics?

(8) Under what circumstances do we need different diffusivities for different tracers?

(9) What are the effects of adiabatic stirring on diapycnal mixing?

(10) Do subgridscale processes provide stochastic forcing?

**IMPACT/APPLICATION**

**TRANSITIONS**

**RELATED PROJECTS**

**REFERENCES**

**PUBLICATIONS**

Müller, P. and D. Henderson, 2001: "From Stirring to Mixing in a Stratified Ocean." Proceedings, 'Aha Huliko'a Hawaiian Winter Workshop, School of Ocean and Earth Science and Technology, Special Publication.

Müller, P. and C. Garrett, 2001: From Stirring to Mixing in a Stratified Ocean. *Oceanography*, The Oceanography Society. (submitted)

**PATENTS**